

THURSDAY, SEPTEMBER 30, 1880

## LANDSLIPS

FEW disasters impress the mind so vividly with human helplessness as those that arise from disturbance of the solid ground beneath our feet. The most devastating hurricane can in some measure be foreseen and provided against. Skill and foresight continually do battle with the fury of the waves, and prove on the whole victorious. We are so familiar with the restlessness of air and ocean that the havoc wrought by these elemental powers does not carry with it the sense of aught unusual or against which we may not hope successfully to contend. But to find that the earth beneath us, to which we have, consciously or not, trusted as the only stable feature in our landscape, gives way in a moment of unsuspecting calm, that the everlasting hills are themselves perishable like everything else, that ruin and death may in an instant overwhelm alike scenes of sylvan quiet and of active human industry, brings to the mind that practically experiences the sensation a horror to which there is hardly any parallel in the long list of calamities that thin the ranks of mankind.

Terrestrial commotions of this nature are obviously divisible into two classes. There are first tremors, of which the far-reaching and destructive earthquake is the most signal example. Much has been said and written about the cause of earthquakes, but we are still far from a satisfactory solution of the problem. Probably more causes than one conspire at different times to produce the impulse which sets the earth-wave in motion. But whatever may be their nurture and origin, these operations belong to that large class in which the internal temperature of the planet, with the results of its reactions and its diminution is the chief factor. In the second place come the disturbances arising from the working of the different agents which are set in motion by the direct influence of the sun. Among these the operations of running water are by far the most important.

There can be no doubt that it is in this second class of phenomena that the melancholy catastrophe at Naini Tal must be placed. In various ways the action of running water disturbs the equilibrium of large masses of rock at the surface. The frequent undermining of its banks by a rivulet or river, with the consequent fall of slices of earth or rock into the stream, is a familiar illustration. The dislocation and dislodgment of portions of cliffs by the wedging influence of frozen water is another common example. But the most extensive changes of this kind arise from the influence of water underneath the surface, where the geological structure of the ground happens to be favourable. Trickling through the pores, joints, and fissures of rocks, rain or melted snow makes underground channels for itself. In the course of its progress it sometimes dissolves away large quantities of stone, or loosens and carries away in mechanical suspension the minuter particles of rocks. When this abstraction of materials takes place along a subterranean slope, the lower end of which comes out on the side or bottom of a valley, the effect is to enfeeble the support of the mass of rock resting upon the slope.

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Eventually this overlying mass may by gravitation break off from its floor and slide down into the valley below. Or should an open porous layer form the platform on which the side of the valley or cliff rests, copious rain may so saturate it as to loosen the cohesion of the superincumbent mass, which, when its weight overcomes that cohesion, is launched forward into the low ground below it. The saturated stratum may be compared to the grease put upon the beams on which a ship is launched from the building-yard. The moisture lubricates the bottom of the overlying rock and allows it to slide down. Such "landslips," as they are termed, are of common occurrence in countries with a copious rainfall, where the ground is uneven and rests on rocks containing easily permeable strata intercalated among others of a more impervious kind. The dislodged mass rushes down with irresistible impetus, breaking up into tumultuous piles of ruin, under which woods, meadows, gardens, fields, houses, and their inhabitants are almost instantly overwhelmed.

Every summer tourist whose wanderings have led him round the coasts of these islands is doubtless familiar with tracts of landslip, some comparatively recent, others so ancient as to go back far beyond the times of tradition or of local history. He will remember how in localities where the scenery would otherwise be of the tamest kind, the ground has been thrown into picturesque knolls and crags, with little glens and valleys winding through them, how the gathered drainage tumbles over miniature falls or collects into diminutive tarns which, in all save size, remind him of mountain lakes, and how over the whole scene the kindly hand of nature has spread her verdure, healing the scars of the original catastrophe by hanging festoons of ferns and mosses over the shattered rock, smoothing and carpeting with velvet turf the once naked floors of loose detritus, and scattering over dingle and den a pleasant shade of copsewood. The under cliffs of the Isle of Wight and other parts of the south coast, the clay cliffs of Sheppey and Yorkshire, the northern sea-front of the Antrim coast, the shores of Skye and adjacent islands of the Inner Hebrides furnish admirable illustrations of every stage in this history, from the raw wound of last year to the fairy-like scenery which conceals the landslips of remote centuries.

Fortunately in Britain we have no harrowing chronicle of human death connected with the story of our landslips. Yet these have not been without occasional loss of life, and sometimes considerable destruction of property. It has been estimated that the coast of Yorkshire between Spurn Point and Flamborough Head loses about  $2\frac{1}{2}$  yards annually, slice after slice of the clay cliff slipping down to the beach, where it is readily attacked and removed by the waves. The clay cliffs of the Isle of Sheppey suffer similar rapid removal, while the chalk cliffs of the Isle of Thanet have had a yearly loss of three feet. From fields that were ploughed and sown with corn in spring segments slip down, so that in these detached portions the crop may be seen ripening half way down the cliff. In the well-known landslip of December, 1839, near Lyme Regis, a strip of chalk cliff three-quarters of a mile long, 240 feet broad, and from 100 to 150 feet high was undermined by the descent of continuous heavy rain and the saturation of a thick deposit of loose sand underneath. It consequently slid

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bodily forward on the beach, breaking up into segments in its progress, and carrying fields, trees, and houses along with it. Unquestionably the most appalling disaster of the kind which has happened in recent times was the celebrated Fall of the Rossberg in 1806, a mountain lying behind the Rigi, and composed like it of sandstone and conglomerate. In this case also there had been much previous heavy rain, which, filtering along a porous sandy bed inclined at a steep angle towards the valley, undermined the support of the overlying thick sheet of massive conglomerate. The whole hill-side gave way and several villages and hamlets, with somewhere between 800 and 900 people, were buried under the ruins. To this day the scar on the slope of the mountain is unhealed, and the piles of huge angular blocks, even to the further side of the valley, remain as memorials of the homesteads and villagers that lie buried below.

The recent catastrophe at Naini Tal is another illustration of the same geological process. The locality is situated on the soft Tertiary deposits which flank the sub-metamorphic and more ancient crystalline rocks of the Himalaya range that towers behind. It possesses one of the few known sheets of water on the Himalayan slopes, nestling among irregularly shaped hills. There is every reason to believe that these hills have derived their present contour not only from extensive denudation by the heavy rainfall, but also from the operation of former landslips, and that the lake itself, to which the place has owed so much of its attractiveness, lies in a hollow formed by the same cause. It has been suggested that the late accident arose from the cutting of a roadway along the base of the hill. But this seems an altogether improbable and unnecessary supposition. The structure of the ground is itself sufficient to account for landslips, apart altogether from the mere superficial interference of any road-making. According to the telegraphic reports there had been a particularly heavy rain, no less than twenty-five inches having fallen in forty hours. The annual rainfall at Naini Tal is stated to be ninety inches, so that more than a quarter of the whole yearly rain fell in less than two days. But this year, at least, the rainfall must have been greater, for Mr. Commissioner Taylor, who was charged with the care of the roads in the district and met his death in the recent catastrophe, wrote on August 17 last that eighty inches of rain had fallen in the previous two months. By such a violent downpour the loose soil is swept off the surface, deep gashes are cut down the slopes, and every streamlet and river is converted into a torrent of liquid mud. But the furrowed soils and rocks likewise absorb much moisture. The water launched in such a deluge over the ground soaks at once into the more permeable gravelly layers and saturates them. When these are inclined towards lower ground and covered with heavy masses of earth or rock, the conditions for the production of landslips are supplied to the full. And such seems to have been the case in this melancholy Indian disaster.

The question arises, Can any steps be taken to guard against a repetition of the calamity? We may take it for granted that Naini Tal, in spite of its recent visitation, will continue to be a favourite resort from the arid plains below. The chance of an occasional destructive landslide will not deter men from coming year after year to gain

renewed health and rest in the pure air of these uplands. It is obviously impossible to prevent landslips, except such minor falls as could not do any extensive damage. The only resource is to fix the sites of stations and houses on such spots as will either be free from risk of accident or on which the risk will be reduced to a minimum. This is mainly a geological question, but it is evidently one of the utmost social importance. Among the able staff of the Geological Survey of India there is no doubt an officer whose services could be made available to examine and report upon the structure of the ground at Naini Tal with special reference to this question. There ought to be first a careful inquiry into the details of the causes that led to the recent sad event, and with the experience thus gained a further inquiry into the safety of the other parts of the settlement and of other hill-stations similarly placed. Even in a district liable to destructive landslips sites for houses can probably be so chosen and defended as to be practically exempt from liability to such calamitous visitations as that which we now so heartily deplore. The prodigious amount of rain which in a few days or hours deluges the ground in these regions presents an engineering problem which demands actual Indian experience on the part of those who would successfully grapple with it. Neither geologists nor engineers accustomed only to the comparatively mild rain-storms of Europe can probably realise the magnitude of the difficulty which such disasters as that of Naini Tal presents for their consideration.

#### ARCTIC NEWS

THE past week has been an unusually interesting one so far as Arctic matters are concerned. First of all we have tidings of the return of the Franklin Search Expedition, sent out from the United States about two years ago, to follow up and unearth if possible some important relics of the Franklin expedition, said to exist among the Eskimo. It may be remembered that upwards of two years ago news reached this country that Mr. Barry, the mate of an American whaler, was told by some Nechelli Eskimo whom he met at Whale Point, Hudson's Bay, that some spoons with Franklin's crest upon them, possessed by the Eskimo, were received from a party of white men who passed a winter near their settlement, where they all died; and that these men left a number of books with writing in them, which were buried. The tale seemed very doubtful, and those best acquainted with the history of Franklin search expeditions considered that it was scarcely necessary to act on the gossip of the Eskimo. However, the people of the United States, who have all along manifested a generous enthusiasm in behalf of the Franklin expedition, thought otherwise, and by private enterprise an expedition was sent out in the summer of 1878, under Lieut. Schwatka, to follow up the traces indicated by the Eskimo. This expedition, after an absence of two years, has just returned, and although the success, so far as its immediate object is concerned, has not been great, it has evidently been able to make important additions to a knowledge of the condition of the inhospitable Arctic region traversed, a region rendered classical, if not sacred, by the early and terrible work of Franklin him-